GLASS TOUCH PANEL

FIELD OF THE INVENTION

The present invention relates to a glass touch panel, and more particularly, to a novel glass touch panel of a glass/glass type which is extremely excellent in high temperature and high humidity proof and also has a merit of a narrow frame and thus is useful for various kinds of displays such as a car navigation display, a video camera display and a monitoring display.

BACKGROUND OF THE INVENTION

There has often been used a touch panel for various kinds of displays such as a CRT display. The touch panel is capable of inputting by a fingertip or a pen.

The basic structure of the touch panel has a glass substrate, a transparent resin substrate above the glass substrate and conductive films on the surfaces of the glass substrate and the transparent resin substrate opposing each other. Also, spacers are optionally used between the glass substrate and the resin substrate.

However, the touch panel having such basic structure has been not always satisfactory in durability, environment proof and wear proof. Further, clearness of the screen has not been satisfactory one and aging discoloration of the screen has been remarkable.

In view of these problem, there has been invented a glass touch panel (refer to JP1997-146707) capable of realizing excellent durability, environment proof and wear proof and also a beautiful screen and less discoloration and color shading. As show in Fig.1, the glass touch panel has a pair of transparent substrates 1a,1b, each having transparent conductive films 2a,2b and opposed to each other at the transparent

conductive film surfaces, wherein the upper transparent substrate 1a as a touch input portion is a glass substrate as well as the lower transparent substrate. It also has an extending wiring 4, a bonding means 5 and a silver electrode 7.

However, this prior art glass touch panel having such distinctive features still needs to be improved much more in temperature and humidity proof in order to meet the severe demands of various industries relating to displays. For example, as a display of navigation system for automobiles and such, high temperature and high humidity proof is required as much as possible.

SUMMARY OF THE INVENTION

In view of the above, it is the main object of the present invention to provide a novel glass touch panel having excellent features such as excellent durability, environment proof and wear proof, a beautiful screen and less discoloration and color shading, as well as having extremely excellent high temperature and high humidity proof compared with the prior art glass touch panel.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing and other objects, features and advantages of the present invention will be better understood from the following detailed description, taken in conjunction with the accompanying drawings, in which:

Fig. 1 is a cross-sectional view showing the prior art glass touch panel.

Fig. 2 is a cross-sectional view showing one example of the glass touch panel of the present invention.

Fig. 3 is a cross-sectional view showing another example of the glass touch panel of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[Adhesive blended with hygroscopic fine particles]

The glass touch panel of the present invention is a touch panel of a glass/glass type and is different from the conventional glass touch panel in bonding of the upper transparent glass substrate 1a and the lower transparent glass substrate 1b as shown in Figs. 2 and 3.

As in Fig. 2 and 3, the glass touch panel of the present invention has the upper transparent glass substrate 1a and the lower transparent glass substrate 1b, each having the transparent conductive films 2a, 2b and opposed to each other. The glass touch panel of Fig. 3 also has superfine particle dot spacers 3 on the transparent conductive film 2b of the lower transparent glass substrate 1b. The transparent conductive films 2a, 2b may be disposed in a suitable shape pattern.

Then, in the present invention, the upper transparent glass substrate 1a and the lower transparent glass substrate 1b are bonded and secured to each other by the use of an adhesive 6 mixed with hygroscopic fine particles, which are fine particles having hygroscopicity.

Therefore, since the hygroscopic fine particles in the adhesive 6 absorb humidity effectively, a humidity proof property much more excellent than that of the conventional panel can be attained even in an extremely high temperature condition. As has been already described the high temperature and high humidity proof property is extremely important in the use of a highly humidity condition, the glass touch panel of this invention can be used more preferably for a display and such of a navigation system in the inside of an automobile and such, for example.

The hygroscopic fine particles must exhibit full hygroscopic feature

even in the adhesive 6. For example, fine silica-type particles having hygroscopic property can be used preferably as such particles. The size of the hygroscopic fine particles should not be limited in any way as long as they realize high temperature and high humidity proof while maintaining adhesiveness of the adhesive 6. However, from a viewpoint of the realization of still more effective coexistence of adhesiveness and high temperature and high humidity proof, for example, a diameter of 50 μ m or less is preferable, a diameter of 5 to 50 μ m is more preferable, and further a diameter of 5 to 10 μ m is much more preferable. As for the mixing amount, although there is naturally a relation with the diameter size, it should not be limited in any way as long as the particles realize high temperature and high humidity proof property and maintain adhesive property of the adhesive 6 at the same time. However, for still more effective coexistence of the both properties, it is preferable to mix the particles with a weight ratio of 10% or less and more preferable with a weight ratio of 5% or less.

[Silver Electrode blended with glass fiber]

As shown in Figs 2 and 3, in the glass touch panel of this invention, it is also preferable to use a silver electrode 7 mixed with a glass fiber. The silver electrode 7 is disposed at a predetermined position of the outer periphery of the upper transparent conductive film 2a and the lower transparent conductive film 2b.

This silver electrode 7 mixed with a glass fiber can maintain the gap between the upper transparent conductive film 2a and the lower transparent conductive film 2b very much reliably, thereby realizing extremely excellent smoothness and preventing screen distortion and unevenness in the image quality and also interference infringes much more effectively than the conventional glass touch panel.

From the viewpoint of realizing sill more effective smoothness, it is preferable to mix the glass fiber into the silver electrode 7 with a weight ratio of 10% or less and also to use a silver paste having a electric resistivity of 5.0×10^{-4} Ωcm or less for the silver electrode 7.

[Performance and Characteristics of Glass Touch Panel]

Additionally, the glass tough panel of the present invention as described above should have the following required performance and characteristics. Of course, the glass touch panel of the invention can easily achieve such high performance and characteristics.

Among all, the light transmittance should be extremely favorable. That is, the light transmittance of 85% or more is preferable and 90% is more preferable. Such high transmittance can provide a beautiful screen.

Next, the operation temperature should preferably be −30 to 65℃ under the condition of 90%RH or lower and the preservation temperature on the condition with no dewing should preferably be −40 to 85℃ (12 hours) under the condition of 95%RH. Further, as for the humidity proof (humidity resistance), the glass touch panel should attain 1000 hours under the condition of 60℃ -95%RH. Furthermore, the glass touch panel should attain the heat resistance at 85°C and the cold resistance at −30°C.

As for the mechanical characteristics, the glass touch panel should generally have the operation load of 10 to 200 g when the switch becomes a conduction state by pressing the upper transparent glass substrate 1a with a test rod having its top end R of 4 mm, diameter of 8 mmϕ and hardness of 60°. The surface hardness should be 5 to 7 Mohs hardness.

Referring to the heat cycle as the durability index, the glass touch panel should operate over 200 cycles, one cycle comprising consecutive procedures of leaving it for 1 hour in an atmosphere of −30℃ and then leaving it for 0.5 hour at a room temperature (or normal temperature) and

further leaving it for one hour in an atmosphere of +85℃ and then leaving it for 0.5 hour at a room temperature (or normal temperature).

In addition, an inactivation gas or air may be injected just before sealing in order to prevent occurrence of interference fringes as well as to smooth the recovery of glass (so called bounce) after input. Further, the operation load may be controlled by measuring it with a tension gauge in order to suit for various purposes. In this case, for example, it is preferable to make the bounce 10 msec or less for an ordinary operation method with a finger.

From a viewpoint of the material for the panel, borosilicate glass or soda glass having a thickness of from 0.15 mm to 0.3 mm may be preferably used for the upper transparent glass substrate 1a. And, for example, the upper transparent glass substrate 1a by borosilicate glass may preferably have physical properties as in the following Table 1.

Table 1
[Physical properties of the upper glass substrate]

Heat expansion coefficient (0 to 300°C)	70 to 80 × 10^{-7}/°C
Young's modulus	7 to 8 × 10^3 kg/mm^2
Poison ratio	0.20 to 0.24
Knoop hardness	590 to 615 KHN_{100}
Density	2.30 to 2.85
Distortion point	480 to 520°C
Gradual cooling point	520 to 580°C
Softening point	700 to 750°C
Volume resistivity	8 to 10 log ρΩ cm
Dielectric characteristic (1 Mhz, at 20°C)	
Dielectric constant	6 to 8
Loss	0.2 to 0.6
Refractive index	1.5 to 1.54

Commercial products can be used for such glass having the above properties.

As for the lower transparent glass substrate 1b, soda glass having

a thickness of from 0.5 mm to 3.0 mm may be preferably used.

Further, as for the transparent conductive films 2a, 2b disposed to such glasses 1a, 1b, thin films of ITO, tin oxide and such, especially, those formed by sputtering and chemical vapor deposition (CVD) may be preferably used. ITO may also be vapor-deposited on deposition of SiO_2 and such. This vapor deposition is a preferred method with regard to the adhesion property and uniformness property of the film.

In the case where the superfine particle dot spacers 3 are disposed as shown in Fig. 3, it is preferable to use a spacer formed by a thermosetting resin and having a diameter of from 20 to 100 μm, a height (=dot thickness) of from 3 to 6 μm and an inter-dot pitch of from 2 to 4 mm.

Electrical properties as a touch panel may preferably be as shown in the following Table 2.

Table 2
[Electrical properties of the glass touch panel]

Rating	DC 5V, 50 mA or less
Insulation resistance	DC 25V, 10 MΩ or more (between upper and lower electrodes)
Linearity	± 3.5% or less
Bounce	10 msec or less (by ordinary finger operation)
Antistatic voltage withstanding	15 kV or higher
Dynamic range	Lower limit: 0 to 0.7V, Upper limit: 5 to 4.6 V

[Method of manufacturing the glass touch panel]

Hereinafter, a method for manufacturing the glass touch panel of this invention will be explained. For example, the glass touch panel of Fig. 3 can be manufactured according to the steps [1] to [6] described below.

Step 1. Formation of transparent conductive films 2a, 2b of ITO and such onto transparent glass substrates 1a, 1b by sputtering and CVD.

Step 2. Patterning of the transparent conductive films 2a, 2b by

resist ink printing, film etching and resist ink peeling or by photo-lithography.

Step 3. Formation of superfine particle dot spacer 3 by resist ink printing and thermosetting or by photo-lithography.

Step 4. Formation of silver electrode 7 by grass fiber mixing, silver paste printing and baking.

Step 5. Printing of adhesive 6 by hygroscopic fine particles mixing and printing and temporal baking or by photo-lithography.

Step 6. Bonding of transparent glass substrates 1a, 1b.

The glass touch panel of this invention to be provided by the above manufacturing steps has an excellent high temperature and high humidity proof owing to the adhesive 6 blended with hygroscopic fine particles and an excellent smoothness owing to the silver electrode 7 blended with glass fibers thereby realizing characteristics of freeness from screen distortion, image-quality unevenness and interference infringes and further of extremely less discoloration and aging change of screen.

It is preferable that the adhesive 6 blended with the hygroscopic fine particles is used as a thermosetting or room-temperature epoxy-type sealant or UV setting acrylic-type sealant. For the thermosetting sealant, temporal baking is needed, and for the UV setting sealant, UV irradiation is needed. As already described, the hygroscopic fine particles must present high temperature and high humidity proof even in these sealants while maintaining the adhesive property of these sealants.

Of course, the glass touch panel of Fig. 2 having an excellent high temperature and high humidity proof and an excellent smoothness can be manufactured as well by the steps 1, 2, 4, 5 and 6 excluding the step 3.

[Example]

A glass touch panel as shown in Fig.3 was manufactured actually

by the following steps 1 to 6. The main dimensions thereof are as the following Table 3.

Table 3 [Main dimensions of the panel]	
Upper transparent glass substrate 1a:	0.2 mm thickness
Lower transparent glass substrate 1b:	1.1 mm thickness
Outer size:	140 × 85 mm
Operation area size:	130 × 59 mm

Step 1. Formation of ITO thin film

At first, transparent zinc borosilicate glass is adopted as the upper transparent glass substrate 1a and soda glass is adopted for the lower transparent glass substrate 1b, and ITO thin films having a film thickness of from 100 to 200 Å and a surface resistance of 500 Ω/□ (ohms per square) are formed as the transparent conductive films 2a, 2b by sputtering and CVD. The transparent zinc borosilicate glass and the soda glass commercially available as a substrate for a thin film were used.

Step 2. ITO patterning

Next, the following treatments are conducted sequentially as ITO patterning.

- Pre-cleaning by supersonic waves
- Coating of resist ink by screen printing
- Baking at 120℃ for 30 min.
- Etching of ITO with nitrate
- Peeling of the resist ink by an alkali
- Post cleaning using supersonic wave

Step 3. Formation of superfine particle dot spacer 3

Next, the following treatments are conducted sequentially for the formation of superfine particle dot spacers.

- Coating of thermosetting resist-ink by printing with a metal mask

• Baking at 200℃ for 60 min. so as to obtain a dot diameter of 20 μm, a dot thickness of 5 μm and a dot pitch of 3 mm.

Step 4. Formation of silver electrode 7

Next, the following treatments are conducted sequentially as formation of silver electrodes.

• Stirring of glass fiber in silver paste with a weight ratio of 1.2%

• Printing of the silver paste

• Baking at 180℃ for about 60 min.

Step 5. Printing of thermosetting epoxy-type sealant as adhesive 6

Next, the following treatments are conducted as printing of thermosetting epoxy-type sealants.

• Stirring of silica-type fine particles having a diameter of 10 μm with a weight ratio of 2.5%

• Seal printing by thermosetting epoxy-type sealant

• Temporal Baking at 90°C for about 30 min.

Step 6. Bonding

As the final step, the upper transparent glass substrate 1a and the lower transparent glass substrate 1b are bonded by the following procedures.

• Bonding by coating minute amount of the silver paste to contact points

• Setting of curing jig.

• Baking at 150℃ for about 90 min. and Cooling gradually

• Cutting

• Injection of air

• Sealing by UV adhesive

By the above manufacturing steps, a glass touch panel having the following performances and characteristics in Table 4 was obtained.

Table 4
[Performances and Characteristics]

Driving system	Analog system
Writing method	Finger or pen
Light transmittance	85% (550nm)
Operation temperature	-30 to 65℃ (90% RH or less)
Humidity proof	1000 hours (60℃ -95% RH)
Heat cycle	250 cycle (-30℃, +85℃)
Heat resistance	85℃
Operation load	80g
Surface Mohs hardness	6
Rating	0.8 mA (DC 5V)
Insulation resistance	12 MΩ (DC 25V)
Linearity	+ 2.0%
Bounce	8 msec

For comparison, a prior art glass touch panel was manufactured by using the steps disclosed in JP1997-146707 and its performances and characteristics are shown in Table 5. This prior art panel has the same outer size and operation area size as the above panel of this invention, which are 140 × 85 mm and 130 × 59 mm.

Table 5
[Performances and Characteristics]

Driving system	Analog system
Writing method	Finger or pen
Light transmittance	85% (550nm)
Operation temperature	-10 to 60℃ (90% RH or less)
Humidity proof	140 hours (60℃ -95% RH)
Heat cycle	15 cycle (-30℃, +80℃)
Heat resistance	83℃
Operation load	100g
Surface Mohs hardness	6
Rating	0.8 mA (DC 5V)
Insulation resistance	12 MΩ (DC 25V)
Linearity	+ 3.0%
Bounce	8 msec

As apparent from Tables 4 and 5, the glass touch panel of this invention thus made is extremely excellent in the operation temperature, the humidity proof, the heat cycle and the heat resistance compared with

the prior art glass touch panel. Consequently, a glass touch panel having an extremely improved environmental proof (resistance) is realized, and such panel is very much suitable to the inner environment of a vehicle. It is need less to say that this panel is suitable not only for the inside of the car, but also for various situations at high temperature and high humidity. Of course, the panel thus made is free from distortion, unevenness and interference fringes on the screen and in the image quality.

As described above in detail, the invention can provide a novel glass touch panel having extremely excellent characteristics such as of durability, operationability, freeness of the design and input accuracy, as well as being extremely excellent in high temperature and high humidity resistance and in smoothness compared with the prior art glass touch panels.